Results and Discussion

PREVIEW

During the field study evidence of the valley elderberry longhorn beetle was found at 64, or 27.8 percent, of the total 230 sites examined (Figure 8). Three additional areas are questionable possibilities. Four adult beetles were observed and collected from three different localities in the eastern Central Valley: Tulare County, Campbell-Moreland Ditch (tributary Tule River) just S of Porterville, elevation ~490 feet, 21 April 1991, one female; Tulare County, Lane Slough (tributary Kaweah River) ca. 5 miles N of Exeter, elevation 405 feet, 30 April 1991, one dead male with atypical dark coloration; San Joaquin County, Mokelumne River ca. 1 mile N of Clements, elevation ~135 feet, 15 May 1991, one male and one female. The remaining 61 sites are reported solely from exit hole evidence. Of the 504 groups of elderberry surveyed, 103, 20.4 percent, had been utilized by the VELB.

Historical data, from previous reports and studies, has also been included in mapping the range of the valley elderberry longhorn beetle (Figure 19). Nearly all of these records are from reliable sources, i.e., biologists having experience with the beetle. Nevertheless, holes in poor condition in dead wood are frequently impossible to identify with certainty, and some of these may have been erroneously reported in the past. It is also possible that non-entomologists, or biologists unfamiliar with its appearance, could mistake other black and red insects for the VELB, especially when in flight. Boxelder bugs (Hemiptera: Lygaeidae) are often very common in riparian woodlands and could be mistaken for the slightly larger male VELBs. Other insects of a similar size and color include largid bugs (Hemiptera: Largidae), wasps, and longhorn beetles such as *Crossidius* (Coleoptera: Cerambycidae). Most of the cited adult records are based on captured specimens, and the remainder were field observations by knowledgeable individuals.

DISTRIBUTION

LIMITS OF THE RANGE

On the basis of exit holes records, the range of the VELB extends from Redding (Shasta Co.) at the northern end of the Central Valley to the Bakersfield area (Kern Co.) in the south. Adults have been taken northward almost to Red Bluff (Tehama Co.), and as far south as Porterville (Tulare Co.) and an unknown location in Kern County (museum specimen, not seen). North of Sacramento, adult VELBs have been observed only along the Sacramento River. In the foothills of the western Sierra Nevada, adults have been found up to 2220 ft. in elevation, and exit holes up to 2940 ft. Along the eastern edge of the Coast Ranges, adults have been found up to 500 ft., and holes up to 730 ft. in elevation. During this study, exit holes were recorded at a minimum elevation of 30-40 ft., and adults at 130 ft., in the Central Valley. Figure 19 illustrates the known range of the VELB based on current and historic records.

NORTH:

Several VELB exit holes, possibly recent, were found in Redding (Shasta Co.) at the Sacramento River, river mile (RM) 296E, elevation ~490 ft. Possibly recent exit holes were also found at two other sites along the Sacramento River in Shasta County at river miles 282W and 274W. The furthest north an adult has been taken was in Tehama County at the Sacramento River just E of Proberta, RM 235W, elevation 230 ft. (Jones and Stokes 1985).

SOUTH:

Emergence holes were found along Caliente Creek between Caliente and Loraine up to an elevation of ~2400 ft. All of these were old and most were in poor condition, but branch samples showed characteristic VELB tunneling. Shields (1990b, 1990c) also reported holes from this area. An adult VELB was collected at an unspecified date and location in Kern County, but it was not examined during this study (Halstead 1990).

EAST:

Emergence holes were discovered at the following localities at the eastern edge of the Central Valley or in the western Sierra Nevada foothills: Tehama County, Paynes Creek near Paynes Creek (town), elevation ~1875 ft. (old holes); Butte County, Big Chico Creek just NE of Chico, elevation 280 ft. (recent and old holes); Butte County, Feather River SW of Oroville, elevation 125 ft. (old holes); Placer

County, Miners Ravine (tributary Dry Creek) NNW of Folsom Lake, elevation ~490 ft. (recent and old holes); El Dorado County, Anderson Creek (tributary South Fork American River) NNE of Folsom Lake, elevation ~860 ft. (recent and old holes); Amador County, Sutter Creek just W of Ione, elevation ~265 ft. (recent and old holes).

An adult VELB was collected in 1974 at Mariposa in Mariposa County at an elevation of approximately 2000 ft. More recently, Halstead (1989) reported the collection of a beetle from Coarsegold in Madera County at 2220 ft., the highest recorded elevation, and observed numerous exit holes northeast of Oakhurst along a tributary of the Fresno River at the even higher elevation of 2540-2940 ft. He has also collected adults along the Kings River and West Fork Byrd Slough in the Centerville/Sanger area, Fresno County, at elevations of 350-400 ft.; recent exit holes were observed in that vicinity during this survey. In Tulare County, dead adults were found by Halstead and others (1990) in the Middle Fork Kaweah River near Sequoia National Park at 2200 ft. During this study recent exit holes were seen along the Tule River up to an elevation of 550 ft. just below Lake Success, in addition to an adult collected at ~490 ft. near Porterville.

WEST:

There are many fewer records to delimit the extent of the range of the valley elderberry longhorn beetle along the western margin of the Central Valley. In the Sacramento Valley exit holes were noted at two localities in Tehama County, Thomes Creek near Paskenta, elevation ~730 ft. (old holes), and Stony Creek just below Black Butte Reservoir, 380 ft. (recent and old holes); from many spots along Cache Creek up to an elevation of ~520 ft. NW of Woodland (Yolo County) (recent and old holes); and from Napa and Solano counties NW of Fairfield at a maximum of ~310 ft. elevation (recent and old holes). The only known adult specimens are from Solano and Yolo counties along Putah Creek west of Winters, the most western of which was collected at ~500 ft. from Cold Canyon just below Lake Berryessa.

No evidence of the VELB was found in the Sacramento-San Joaquin Delta (Delta) except for some emergence holes seen at the western margin near Dixon. Although Arnold (1984, 1985) reported observing an adult and exit holes along the Middle River southwest of Stockton (San Joaquin County), none were found during this survey.

Except for a couple along the San Joaquin River, there are no records of the VELB from the western side of the San Joaquin Valley. Due to the locality, there is a possibility that the two specimens collected in Merced County along Los Banos Creek at an elevation of 400-440 ft., and identified as the nominate subspecies (Andrews et al. 1987), may be *D. c. dimorphus* or intergrades. An occassional male VELB has most of the elytral surface dark as do male *D. c. californicus*, and unfortunately only one male beetle was collected. The near-absence of records from the western part of the San Joaquin Valley could be due to

the scarcity of habitat caused by agricultural conversion, and the ephemeral nature of the streams draining the inner Coast Ranges. However, particularly in the case of stream canyons where *Sambucus* may be present, the lack of survey effort may be a large factor.

THE SACRAMENTO VALLEY

Survey sites within drainage basins will be reviewed from lower to higher elevations, except for those along the Sacramento River which will be discussed from north to south.

SACRAMENTO RIVER:

Adult VELBs have been taken at six localities along the Sacramento River from RM 235W just E of Proberta (Tehama Co.) to RM 84.3W SE of Knights Landing (Yolo Co.) by Jones and Stokes (1985). During that study exit holes were found from RM 239.5W just S of the Red Bluff Diversion Dam (Tehama Co.) to RM 62.5W at Bryte (Yolo Co.). Before emergence holes were found in Redding (Shasta Co.), RM 296E, during this survey, the northernmost known exit holes were in Red Bluff (Ford and Villa 1987). The most southern exit hole records are from opposite the mouth of the American River in Broderick (Yolo Co.) (Larry Seeman Associates 1985b).

Because of the extensive study of the river between Red Bluff Diversion Dam (RM 243) and Sacramento (RM 60) by Jones and Stokes (1985, 1986, 1987b), the focus of this survey was primarily N of Red Bluff.

No elderberry was seen along I-5 or other roads N of Redding to near Lakeland N of Shasta Lake, elevation ~1200 ft. In the Whiskeytown-Shasta-Trinity National Recreation Area just below Shasta Lake and Dam (#54), elevation ~680 ft., several clumps of elderberry along the W bank were examined without success. A solitary plant at a tributary, Rock Creek (#55), also had no sign of the VELB.

The most northern exit holes were found in Redding at Turtle Bay East Fishing Access (City of Redding) (#56) just SE of the Hwy. 299 bridge, RM 296E, elevation ~490 ft. Recent and old exit holes were found in one grove of *S. mexicana*, four other clumps had none (Figure 20).

Recent and old exit holes were present in three groups of elderberry at Anderson River Park (City of Anderson) (#60), RM 282W, elevation ~395 ft. Natural vegetation had been removed from much of the area, giving it a "park-like" look, but there were some places where the riparian forest was dense (Figure 21). The elderberry shrubs were mostly young; only a few mature individuals were seen.

Excellent VELB habitat was found at 41 acre Reading Island Recreation Area (BLM)(#61), E of Cottonwood, between the river and Anderson Creek, RM 274W, elevation ~365 ft. Huge clumps *S. racemosa* var. *microbotrys* grew singly (Figure 9) or in clusters in an elderberry savanna (Figure 43) which bordered a narrow band of riparian forest with oak, ash, and grape. Numerous exit holes were present, a few of which were probably made this year. Extensive recent pruning and trimming of *Sambucus*, both live and dead wood, had been done near the campsites by the California Conservation Corps (Figure 37).

Halstead (1990) reported emergence holes from along Jellys Ferry Rd. near RM 271E. Seven groups of elderberry at two spots (#57) on the road were searched during this survey; only poor-condition old holes in dead wood were seen, none of which could be verified as having been caused by the VELB.

No elderberry was seen at Jellys Ferry Fishing Access (BLM) at Jellys Ferry Bridge near RM 267E, nor at Paynes Creek Recreation Area (BLM), RM 261E. A few scattered clumps of elderberry were examined at Bend Bridge Public Fishing Access (Tehama Co.) (#58), and in Bend (#59), RM 258-253E; no evidence of the VELB was noted.

Jones and Stokes (1985) collected the most northern adult VELB specimen E of Proberta at RM 235W, elevation 230 ft.

A section of the new Sacramento River National Wildlife Refuge (Flynn Tract) at RM 230-231W SE of Gerber was surveyed (#112). The 171 acre riparian area between the river and Elder Creek, elevation ~205 ft., had numerous *S. racemosa* var. *microbotrys* along the margin of riparian forest adjoining cultivated fields (Figure 22). Many clean-cut holes were found, at least one of which was recent.

Many large elderberry shrubs/trees were surveyed at Kopta Slough Preserve (The Nature Conservancy) (#113) between the river and Kopta Slough, RM 219W, elevation ~175 ft., E of Corning (Figure 23). This site is adjacent to Woodson Bridge State Recreation Area where exit holes have been previously reported (Jones and Stokes 1985). Dense riparian vegetation was present similar to that of the Flynn Tract. Exit holes, a couple of them recent, were abundant in *S. racemosa* var. *microbotrys*.

Huge groves of elderberry were seen, but not examined, between the Sacramento River and Rock Creek on Hwy. 32 W of Chico.

Jones and Stokes (1985, 1987b) took adult beetles downstream in Butte Co. E and SE of Bayliss at RM 177.7E and 179.4E, in Glenn Co. just NW of Butte City at RM 169.5W, in Colusa Co. SE of Colusa at RM 138.7W and N of Grimes at RM 126.5W, and in Yolo Co. SE of Knights Landing at RM 84.3W.

No adults or exit holes have been reported downstream from the Sacramento area. Areas surveyed are discussed under the sub-section called "The Sacramento-San Joaquin Delta."

SIERRA NEVADA DRAINAGES:

Cow Creek (Shasta Co.)

No elderberry was seen NE of Redding along Little Cow, Dry, Yank, Oak Run, Woodman, Stillwater, or Salmon creeks, all tributaries of Cow Creek. The area was surveyed up to an elevation of ~1500 ft., where the vegetation was mostly mixed chaparral-foothill woodland dominated by pine, manzanita, and yerba santa.

Battle Creek (Shasta, Tehama Co.)

Only the lower stretch to the end of Coleman Fish Hatchery Rd., about 8 mi. ENE of Cottonwood, was surveyed. No elderberry was found.

Paynes Creek (Tehama Co.)

Along Hwy. 36 elderberry occurred mostly in isolated clumps or groves. Four sites (#66-69) were examined from a few miles W of Dales, upstream to just E of the town of Paynes Creek; several old exit holes in living branches were found at two of these. The highest one (#67), elevation ~1875 ft., was an isolated clump in an open pasture (Figure 44); the other (#68), at 1040 ft., was a small grove of elderberry growing among buckeye and oak (Figure 24). Samples from both sites were identified as *Sambucus racemosa* var. *microbotrys*.

No elderberry was found at Paynes Creek Recreation Area (BLM) between Paynes Creek and the Sacramento River.

Deer Creek (Tehama Co.)

Elderberry occurrence was sporadic along roadside fencerows in open fields NE of Vina, and in riparian vegetation along Deer Creek. No exit holes were found at the three sites surveyed: Deer Creek (#109), Delaney Slough (#110), and China Slough (#111).

Big Chico Creek (Butte, Tehama Co.)

Bidwell Park (City of Chico) is a mostly undisturbed riparian corridor of 2250 acres surrounding Big Chico Creek from downtown Chico to several miles up Chico Canyon. *Sambucus mexicana* was very abundant

in the lower park at an elevation of ~280 ft. where three sites (#119-121) were inspected (Figure 25). Two of these had exit holes, but only one recent hole was located (#121). The six-mile Upper Park Road parallels the creek through open, dry grassland and pockets of riparian forest where the canyon is shallower. Three different groups of elderberry without holes were examined up to ~740 ft. in elevation (#122).

Butte Creek (Sutter, Colusa, Glenn, Butte Co.)

No evidence of the VELB was found along Butte Creek. One site was examined at Gray Lodge Waterfowl Management Area (CDFG) (#215), and three others nearby (#214,216,217); the elderberry bushes were in isolated groups in this area. Little or no habitat was found upstream from the corner of Glenn and Butte counties to near Chico.

Sutter Basin (Sutter Co.)

No elderberry was seen at Sutter National Wildlife Refuge SW of Yuba City.

Feather River (Sutter, Yuba, Butte Co.)

At Bobelaine Audubon Sanctuary (#86) just downstream from the mouth of the Bear River, NW of Nicolaus, *Sambucus* was scattered in an elderberry savanna between Lake Crandell and Sand Spit Slough at an elevation of ~35 ft. Although only a few old holes in dead wood and poor condition were found, sectioning of wood specimens revealed tunnels that were probably made by the VELB. An exit hole had been previously reported from the sanctuary by Sorensen (1987).

Scattered elderberry shrubs were surveyed at eight sites (#165-172) along the east bank levee from just N of Marysville almost to the mouth of Honcut Creek (Figure 26), and at one site (#173) on lower Honcut Creek (Figure 42). Recent and partly healed VELB exit holes were noted in *S. racemosa* var. *microbotrys* at two of the sites (#172,173) at an elevation of 75 ft. Holland (1985a) reported finding exit holes in this area E of Live Oak in 1985. There was no sign of the VELB in elderberry at one site (#218) just SE of Honcut on North Honcut Creek.

Sambucus mexicana (#178) was scattered throughout Oroville Wildlife Area (CDFG) SW of Oroville. Several old exit holes were found in dead wood at the six sites (#174-179) examined at 115-125 ft. in elevation. No elderberry shrubs/trees were seen just below Lake Oroville on Oroville Dam Road.

Yuba River (Yuba, Nevada, Sierra Co.)

No evidence of VELB presence was found along the Yuba River, but access was poor along the lower section because of gold dredging operations. Isolated and scattered elderberry plants were surveyed at three sites NE of Marysville, near Hallwood (#180,181) and S of Browns Valley (#182). None were seen further up the Yuba River, or along Big Ravine or Slacks Ravine up to Penn Valley E of Smartville, elevation ~1440 ft.

Bear River (Sutter, Yuba, Placer, Nevada Co.)

There were many fire-scarred elderberry shrubs/trees, mainly in rows inside and at the base of the levees, near the Pleasant Grove Rd. bridge SW of Wheatland, elevation 60-65 ft. (#24,25). Although numerous plants were examined, recent VELB exit holes were noted in only two clumps of *S. racemosa* var. *microbotrys*.

No elderberry shrubs/trees were seen along Spenceville or Camp Far West roads up to Camp Far West Reservoir, where two isolated clumps without exit holes were found below the dam (#87), and another on the north shore of the lake (#88).

Only a few small elderberry clumps without exit holes were seen along Dry Creek, a tributary of the Bear River, in the Spenceville Wildlife Management Area (CDFG) E of Marysville.

Coon Creek (Sutter, Placer Co.); Dry Creek (Sacramento, Placer Co.)

Kavanaugh (1991) recently reported emergence holes from the Coon Creek drainage NW of Clipper Gap at an elevation of 1800-2000 ft.

During this study elderberry clumps were examined along two small tributaries of Dry Creek, which enters the Sacramento River just north of the mouth of the American River. Recent exit holes in *S. racemosa* var. *microbotrys* were found at two sites (#21,22) E of Rocklin along Miners Ravine (elevation 400-500 ft.), which parallels the northwest shore of Folsom Lake (Figure 48). Only old holes were seen along Secret Ravine NE of Rocklin near the Sierra College campus at an elevation of 300-320 ft. (#230).

American River (Sacramento, Placer, El Dorado Co.)

Adults and numerous exit holes have been previously reported from just above the mouth of the American River upstream to Lake Natoma. That stretch of river in the Sacramento area was not surveyed during this study, but exit holes were informally noted at Sacramento Bar and near the Business I-80 bridge.

A single isolated clump of elderberry was searched at Rattlesnake Bar, Folsom Lake State Recreation Area, near the North Fork arm of the lake (#23). There was no sign of the VELB.

Two sites were surveyed along Rattlesnake Bar Road, South Fork American River drainage. Many recent VELB exit holes were found in isolated elderberry shrubs just NE of Folsom Lake State Recreation Area Peninsula Campground (#99) in an oak woodland habitat, elevation ~600 ft. (Figure 46). Four large clumps of *S. mexicana* were growing in a wet roadside ditch, not a typical riparian situation. All exhibited evidence of cutting and pruning of major trunks. Just to the NE near Anderson Creek (#100), recent holes were seen in an isolated stand on a dry hillside at ~860 ft.

No emergence holes were seen at sites along the South Fork and tributaries upstream from Folsom Lake. In Coloma at Marshall Gold State Historical Park (#96), elevation ~760 ft., several clumps of *S. mexicana* were examined along the South Fork. Isolated groups of elderberry were checked on Salmon Falls Rd. S of Pilot Hill (#101), at Hastings Creek E of Pilot Hill (#98), at Granite Creek S of Lotus (#97), and on Hwy. 49 between Placerville and Coloma (#95). The elderberry at the Hastings Creek locality, elevation ~960 ft., was *S. racemosa* var. *microbotrys*. No *Sambucus* was seen at the Hwy. 193 crossing at Chili Bar, 966 ft.

Cosumnes River (Sacramento, El Dorado, Amador Co.)

The Cosumnes River was not surveyed during this study, but there are several previous records. Jones and Stokes (1987a) and Arnold (1984) found exit holes at four localities along the river from Twin Cities upstream to a few miles SW of Sloughhouse. An adult beetle was collected in 1964 between Deer Creek and the Cosumnes River just S of Sloughhouse, the most upstream record (Williams 1986).

Dry Creek (Sacramento, San Joaquin, Amador Co.)

Arnold (1984) reported finding exit holes just E of Galt. During this survey no sign of the VELB was found at two sites (#136,137) on the south bank about 7 mi. E of Galt.

Recent and old emergence holes in *S. mexicana* were examined at four sites at an elevation of ~265 ft. along Sutter Creek, a tributary of Dry Creek, in Amador County just W of Ione (#138-141).

Mokelumne River (Sacramento, San Joaquin, Amador, Calaveras Co.)

In 1985 Arnold reported seeing five adult VELBs along a 15-mile stretch of the Mokelumne River from its confluence with the Cosumnes River upstream to Lodi Lake. The lower portion near the mouth of the Cosumnes River may be considered part of the Sacramento-San Joaquin

Delta. During this study the river was surveyed at five localities from Woodbridge to the north shore of Camanche Reservoir.

Many huge, mature stands of *Sambucus* were seen at Woodbridge Regional Park (San Joaquin Co.) (#144) NW of Lodi. Although Arnold reported observing an adult nearby in 1985, no exit holes were found during this study.

One recent and several old exit holes were found in *S. mexicana* just NW of Lockeford at the Lockeford Plant Materials Center (USDA). The clumps were growing along the south bank levee with willow, cottonwood, oak, and blackberry at 60-65 ft. in elevation (#70).

Two adult VELBs (Figures 1, 66) were collected at a cemetery just N of Clements at an elevation of ~135 ft. The site (#72), 0.3 mi. SE of the Mokelumne River, was not a typical riparian habitat. Many large clumps of *S. mexicana* were growing along the enclosing fence, trunks often just outside on the margin of plowed agricultural fields (Figures 45, 65); plants were also scattered throughout the cemetery. Many exit holes, both recent and old, were present in several clumps. Some old, healed holes were also found in a line of mostly young elderberry shrubs along the roadside to the south (#71). Many *Sambucus* were seen from the road, but not examined, at Stillman Magee Regional Park (San Joaquin Co.) on the S bank of the river.

A lone elderberry with old, unrecognizable holes, was examined in a grassy field just below Camanche Reservoir Dam (#73), elevation ~115 ft. None were seen along the N shore of Camanche Reservoir.

No elderberry was found at a tributary, Bear Creek, SE of Lockeford and S of Clements, two localities where Arnold had reported finding exit holes in 1984.

COAST RANGE DRAINAGES:

Cottonwood Creek (Shasta, Tehama Co.)

Elderberry was not seen along Gas Point Rd. which parallels Cottonwood Creek up to the confluence of the North and Middle forks, nor on Foster Rd. along the Middle Fork. Four sites (#62-65) with isolated individuals, and a grove, were surveyed along the North Fork up to an elevation of ~650 ft. ca. 2 mi. NW of Gas Point. No evidence of VELB presence was found.

Thomes Creek (Tehama Co.)

Six sites were surveyed from just W of Richfield near I-5 to near Paskenta. *Sambucus* was very abundant at Rawson Rd. bridge W of

Richfield (#103,104), but the plants were in poor condition with droopy, yellowish foliage, perhaps due to drought stress. Although many mature trees and clumps were searched, no emergence holes or adults were found. Upstream the elderberry became scattered and appeared more sporadically. No exit holes were seen at three sites from just E of Henleyville to Flournoy (#105-107). Just NE of Paskenta (#108), elevation ~730 ft., one of several large clumps on the north bank of the creek had an old healed exit hole. Southwest of Paskenta the terrain became quite open, hilly, and dry, with little suitable habitat for *Sambucus*.

Stony Creek (Tehama, Glenn Co.)

Sambucus at five localities (#114-118) were examined along the north and west shores of Black Butte Lake up to an elevation of 490 ft. at North Fork Stony Creek. All were isolated individuals or clumps. One massive *S. racemosa* var. *microbotrys*, with 3 trunks of 10+ in. in diameter, bore several recent and old holes. It was located below a levee, just S of the Stony Creek outlet from the reservoir, at 380 ft. in elevation (#118) (Figure 27).

Colusa Basin (Glenn, Colusa Co.)

No elderberry shrubs/trees were seen in the Sacramento, Delevan, or Colusa National Wildlife refuges.

Cache Creek (Yolo, Lake Co.)

Many *Sambucus* with VELB exit holes were found along Cache Creek and Hwy. 16 from ca. 5 miles W of Woodland to ca. 3 mi. NW of Rumsey at an elevation of ~520 ft. Five of six sites (#74-79) surveyed had numerous old exit holes, and four of them had recent ones. From Woodland to about 350 ft. near Guinda, the road was virtually lined with elderberry; they became more scattered, then isolated, higher up the canyon. The 520 ft. site (#75) was an isolated grove growing in a mixed chaparral-foothill woodland habitat with digger pine, manzanita, toyon, redbud, and big-leaf maple (Figure 47). The species of elderberry occurring at both the lowest (#74) (100 ft.) and highest sites (#75) (~520 ft.) was *S. mexicana*.

Putah Creek (Yolo, Solano, Napa, Lake Co.)

Putah Creek from Lake Solano to Lake Berryessa historically has been considered to be important VELB habitat, and a section of the stream was termed Essential Habitat when the Recovery Plan was formulated in 1984. Adult specimens have been collected from Lake Solano up to Monticello Dam (elevation ~500 ft.) on Putah Creek, and from Stebbins Cold Canyon Reserve (Univ. of California Reserve System) to the south. That the VELB population is still extant in the area is evidenced by a recent

exit hole seen at Lake Solano Park (Solano Co.) (#222) in a *S. mexicana* trunk. Some of the elderberry had been damaged by cutting.

A couple of miles to the south of Lake Solano a recent exit hole was discovered along Pleasants Valley Creek (#221), a tributary of Putah Creek, at an elevation of ~200 ft. The host was determined to be *S. racemosa* var. *microbotrys*. Two other sites (#219,220) nearby had no sign of the VELB.

Several adult specimens collected from the Davis area in the 1920's and 1930's are housed in museum collections.

Ulatis Creek (Solano Co.); Alamo Creek (Solano Co.)

Arnold has reported finding VELB exit holes in Vacaville from Ulatis Creek (1990) and Alamo Creek (1991), tributaries of Cache Slough.

Suisun-Fairfield Basin (Solano, Napa Co.)

This is a small drainage basin in the eastern foothills of the Coast Range NW of Fairfield. It is composed of creeks which flow south into Grizzly and Suisun bays below the mouth of the Sacramento and San Joaquin rivers. Five sites on two different creek systems were surveyed.

An old exit hole in a dead branch was found in an isolated stand of *S. mexicana* on Gordon Valley Rd. at Suisun Creek or a tributary (#127). Elderberry was scattered along Wooden Valley Rd. which follows Wooden Valley Creek, a tributary of Suisun Creek. A recent hole was seen in a clump of *S. mexicana* at one site (#128) (Figure 28), but none at another site nearby (#129).

Two sites (#123,124) were surveyed along Ledgewood Creek on Clayton Rd. An old hole in dead wood was examined in an isolated stand at one of these (#123) (Figure 29). Old holes were also noted at two sites (#125,126) with many clumps elderberry along Gordon Valley Rd. at Gordon Valley Creek, a tributary of Ledgewood Creek (Figure 12).

Elderberry was not found along either Green Valley Rd. or Green Valley Creek.

THE SACRAMENTO-SAN JOAQUIN DELTA

The various sloughs and canals in this area are treated as tributaries of either the Sacramento or San Joaquin River.

Elderberry distribution in the Sacramento-San Joaquin Delta was spotty, and stands were often isolated from one another. Clumps that had been burned were frequently found along the levees. Although many areas were surveyed, evidence of VELB infestation was found at only one site at the edge of the Delta near Dixon.

SACRAMENTO RIVER:

Ten sites with elderberry were examined; VELB exit holes were seen at only one of them. The areas surveyed were as follows: (1) the Sacramento River on Hwy. 160 between Hood and Courtland (#27); (2) the levee immediately to the SSW of South Stone Lake between Hood-Franklin and Lambert roads (#26); (3) Elk and Sutter sloughs from Clarksburg S to confluence with Steamboat Slough SW of Vorden (#133), lots of elderberry; (4) Miners Slough SW of Paintersville and W of Vorden (#132); (5) Steamboat Slough from Hwy. 160 to the Sacramento River W of Vorden and Ryde, and N of Isleton (#28, 2 localities); (6) the Sacramento River just upriver from the mouth of Cache and Steamboat sloughs (#28); (7) Georgiana Slough E of Ryde and Isleton (#29); (8) Brannan Island State Recreation Area between the Sacramento River, Threemile Slough, and Sevenmile Slough SE of Rio Vista (#134), scattered elderberry; (9) The Big Ditch, tributary Lindsey Slough, NE of Birds Landing (#131); (10) Dudley Creek just E of Dixon (#130). At the last site on the edge of the Delta, 3 clean-cut old emergence holes were found in a large isolated clump of *S. mexicana*. The stand was in poor health and had burn scars.

SAN JOAQUIN RIVER:

Arnold (1984, 1985) reported finding adults and exit holes along the Middle River SW of Stockton and on the lower Mokelumne River near the mouth of the Cosumnes River, but there was no sign of the VELB at any of the nine sites that were examined during this study.

Areas surveyed were as follows: (1) Potato Slough and Venice Island SW of Terminous (#143); (2) Oak Grove Regional Park (San Joaquin Co.) at Bishop Cut NW of Stockton (#142); (3) Middle River (#135), Empire Cut, Whiskey Slough, and Trapper Slough bounding the Jones Tract; (4) Middle River along Wing Levee Rd. between Inland Drive and Undine Rd. ca. 5 mi. SW of Stockton (#80-85).

The latter area (#80-85) was the where Arnold found holes in 1984 and an adult VELB in 1985. Elderberry was very numerous to the east of the road along the outside of the levee, especially in an area 1.2 mi. N of Undine Rd., but many were in poor condition with droopy, yellowish foliage. Three aerial crop dusters were at work in the cultivated fields to the west of the road, which suggested the possibility of

pesticide effects. No sign of the VELB was found although many clumps were examined at six different sites.

No elderberry was observed at Franks Tract State Recreation Area NE of Antioch.

THE SAN JOAQUIN VALLEY

Survey sites within drainage basins are discussed from lower to higher elevations.

SAN JOAQUIN RIVER:

North-South Section

Areas were surveyed from Durham Ferry State Recreation Area just below the mouth of the Stanislaus River south to the mouth of the Merced River. No elderberry was seen at Durham Ferry, but three sites were examined E of Vernalis (#197) and SE of Grayson (#198,199).

One isolated young stand was found at the Merced National Wildlife Refuge SW of Merced (#155), but none were seen at Los Banos or Volta State Wildlife areas (CDFG), or San Luis Reservoir State Recreation Area SW of Santa Nella. Reportedly, there are also none at the San Luis National Wildlife Refuge.

No *Sambucus* was found along Fresno Slough in the Mendota Waterfowl Management Area (CDFG) SE of Mendota.

East-West Section

River access was poor from NW of Kerman upstream to Millerton Lake, and only three sites with elderberry were inspected. No evidence of the VELB was seen, but there are past records from NW of Kerman and in the Herndon area.

Many healthy stands of elderberry grew at the San Joaquin River (south bank) on Gravelly Ford Ranch property N off Ashlan Rd., NW of Kerman (#160). In 1985 VELB exit holes were seen north of the river, due north from the end of Yuba Avenue (Scammell-Tinling 1991).

An adult VELB was collected in Herndon in 1970, and Halstead (1990) reported emergence holes in 14 out of 20 trees inspected at Riverside Municipal Golf Course just NE of Herndon in 1989. An isolated group checked just W of Hwy. 99 and Herndon (#159) showed no sign of the VELB.

Halstead (1990) provided a second-hand report of a 1986 or 1987 adult sighting at Hwy. 41 N of Pinedale in Madera County.

Scattered clumps were checked at the Ball Ranch (#158) on Friant Rd. SW of Friant and Millerton Lake. No elderberry was seen at Lost Lake Recreation Area (Fresno Co.) just SW of Friant, nor at Millerton Lake State Recreation Area on the south shore.

SIERRA NEVADA DRAINAGES:

Calaveras River (San Joaquin, Calaveras Co.)

Twelve sites along the Calaveras River and tributaries were surveyed from N of Waterloo (elevation 60-65 ft.) to New Hogan Lake, as well as an area to the south and southeast of the lake up to an elevation of ~800 ft. Arnold reported seeing exit holes in 1984 and seven adults in 1985 in the area between Hwy. 88 and Waverly Rd.

A few old holes in poor condition, but probably caused by the VELB, were found at three sites N of Waterloo (#89-91). There were many scattered clumps of elderberry growing along the levees on both sides of the dry riverbed. Most large stems had been splintered or cut off near the ground on these *Sambucus*, and the living portion consisted mainly of young growth (Figure 39). A recent exit hole and numerous old ones were found in an isolated elderberry N of Linden (#93), elevation 110 ft. (Figure 30).

Six clumps of elderberry with several recent and old emergence holes were examined at a site between Bellota and the county line (#145) at an elevation of 150 ft. These plants were growing along the roadside some distance from the river.

No exit holes were seen in *Sambucus* along the Calaveras River NW of Linden (#92), Mormon Slough (technically a tributary of the San Joaquin River) near Bellota (#94), nor in an isolated clump in an open field near Indian Creek (#146).

Isolated stands of elderberry were examined at four sites (#147-150) along Hogan Dam Rd. S and SE of New Hogan Lake, mostly along tributaries Bear and Dry creeks. There was no sign of the VELB. At two of these localities the clumps were growing on dry hillsides with scattered oak trees, and appeared to be in poor condition with droopy, yellowish foliage.

Stanislaus River (San Joaquin, Stanislaus, Calaveras, Tuolumne Co.)

Twelve sites along the river were surveyed during this study from Caswell Memorial State Park SW of Ripon upstream to Tulloch Reservoir. The U. S. Army Corps of Engineers (COE) has 16 river parks from the mouth of the Stanislaus River to Goodwin Dam just below Tulloch Dam. Many of these were visited because of easy access, and in some cases, excellent riparian habitat.

Mature elderberry shrubs/trees were very abundant on the margins of the riparian forest at Caswell Memorial State Park (#196). Although many plants were examined, no emergence holes were found. Holes were reported from here in 1985 by Holland (1985b).

McHenry Avenue Recreation Area (COE) (#223) ca. 3 mi. SSW of Escalon, elevation ~70 ft., had a little-disturbed riparian forest of elderberry, boxelder, oak, blackberry, grape, etc. Numerous clumps of *Sambucus* were examined and nearly all had several exit holes, many of them recent. Some of the plants were in poor condition and some had been severely pruned and cut back (Figure 38). Singleton (1987) and Vouchilas (1989) reported finding exit holes at two areas southeast and southwest of the Rd. J6 (McHenry Ave.) bridge.

A few scattered *Sambucus* with old exit holes were seen on private property slated for development on the north bank just W of Jacob Meyers Recreation Area (COE) at the Rd. J7 bridge (#229). The area was an open grassy woodland with oak, boxelder, and elderberry.

At sites upstream the elderberry became fewer in number and more sporadic in occurrence, and none showed signs of VELB infestation. Oakdale Recreation Area (COE) (#224) ca. 1 mi. N of Oakdale, had riparian habitat with willow, cottonwood, oak, and ailanthus, but little elderberry. At Orange Blossom Recreation Area (COE) (#228) ca. 5 mi. NE Oakdale, a few scattered clumps grew with oak, willow, ailanthus, giant cane, and blackberry. Other sites having elderberry were: Valley Oak Recreation Area (COE) (#225) ca. 3 mi. NE of Oakdale, Horseshoe Road Recreation Area (COE) (#226) ca. 3.5 mi. WSW of Knights Ferry, and Knights Ferry Recreation Area (COE) (#227) at Knights Ferry.

Isolated clumps of elderberry growing on the dry, rocky canyon walls were examined at three sites (#152-154) along Tulloch Rd. below Tulloch Dam and Reservoir. The uppermost (#152), at an elevation of ~570 ft., was identified as *S. mexicana*.

Tuolumne River (Stanislaus, Tuolumne Co.)

Downstream from the areas surveyed in this study, Arnold (1984) reported finding exit holes along the Tuolumne River around Modesto and E of Empire. Nine sites with elderberry were examined upstream from N of Hughson to Turlock Lake, elevation ~200 ft.

Seven sites were in the area from N of Hughson to Waterford (#200-206), and of these, two had VELB exit holes. Recent and old holes were found at Site #203 in a *S. mexicana* growing at an elevation of ~65 ft. *Sambucus* was common at Site #206, elevation 80 ft., but it was in poor health and damaged by cutting; two old exit holes were seen. At Site #205 a clump without holes had been burned (Figure 41).

Several large elderberry clumps, fire-scarred and in poor condition, were present at Turlock Lake State Recreation Area (#207,208). No emergence holes were found. No *Sambucus* was seen along the south shore of Modesto Reservoir, nor along the southeast shore of Don Pedro Lake.

Merced River (Merced, Mariposa Co.)

Seven sites were surveyed from near the mouth of the Merced River upstream to Henderson Park (Merced Co.), which is about 5 mi. W of the Merced-Mariposa Co. line.

No sign of VELB presence was found at George J. Hatfield State Recreation Area (#194) near the mouth of the river. Only a few clumps of elderberry were seen in the park, some of which were in poor health, but just to the northeast there was a large healthy grove on private property (#195).

Exit holes were reported by CALTRANS (Walters 1986) at the Hwy. 99 bridge NW of Livingston, and Arnold (1984, 1985) reported observing two adult beetles and exit holes just upstream at McConnell State Recreation Area. No exit holes were found in the park (#193) during this study although numerous *Sambucus* clumps were inspected. Many were fire-scarred and appeared unhealthy.

The most upstream record of the VELB is a collection of two adults by Halstead (1990) at Rd. J7 just N of Cressey, elevation 110 ft. He also observed many emergence holes in the area.

Elderberry stands at five sites upstream were inspected without success. Many plants were growing at the Oakdale Rd. bridge N of Winton (#209,210), and isolated stands were seen near Hopeton (#211) (not at the river) and E of Henderson Park between Snelling and Merced Falls (#212,213). Those at Site #210 had been severely burned, and perhaps killed above the ground (Figure 40).

No elderberry was seen upriver to New Exchequer Dam below Lake McClure.

Chowchilla River (Merced, Madera, Mariposa Co.)

No evidence of VELB presence was seen along the river or the East Fork. Three sites (#190-192) with isolated or scattered *Sambucus* were examined along the lower river from Hwy. 99 NW of Chowchilla to White

Rock Rd. SW of Marguerite. Access upstream was poor. A few isolated clumps were searched at the East Fork Chowchilla River (#163) and a tributary (#164) near the Mariposa-Madera Co. line, elevation ~3000 ft.

Fresno River (Madera Co.)

Halstead has taken an adult VELB along Coarse Gold Creek at Kelshaw Corners, elevation ~1230 ft. (1991b), and reported the collection of another from Coarsegold, elevation ~2220 ft. (1989). He has also seen many exit holes along the Fresno River W of Oakhurst (1990), and along the Lewis Fork near Yosemite Forks NE of Oakhurst (1991c), elevation ~2540-2940 ft. During this study scattered clumps of elderberry were inspected at Coarsegold (#161) and Oakhurst (#162), but no holes were seen. A foliage/inflorescence sample from Oakhurst was identified as *S. mexicana*. The lower river was not surveyed.

Kings River (Kings, Fresno, Tulare Co.)

The Kings River, tributaries, and nearby canals were surveyed at 24 sites from Hwy. 41 up to Pine Flat Dam and Reservoir. The lower Kings River was dry and had very little riparian vegetation; when present, it consisted of a few willow and cottonwood trees, and an occasional elderberry.

In the area from Hwy. 41 upstream almost to Hwy. 43, 12 sites were examined on the South Fork (#37,38), North Fork (#183), three canals/tributaries (#39-41), and the main river channel (#184-189). A possible old emergence hole in dead wood was found ca. 2 mi. W of Hardwick near the river (#186) at an elevation of ~245 ft.; there were quite a few *Sambucus* at this locale (#186-188). The scattered pockets of elderberry along this section of river showed much evidence of abuse in the form of cutting and burning.

There were many clumps of elderberry growing at two sites (#156,157) between Hwys. 43 and 99 S of Kingsburg, but no exit holes were seen.

Old, enlarged holes which might have been VELB exit holes were found at sites S of Reedley at Rd. J40 (#42) and just W of Reedley (#43). Only one of these (#43) was reported as a possible locality record (Figure 31).

It appears that a relatively large VELB population exists along the river, tributary creeks, sloughs, and canals in the area around Sanger and Centerville. Halstead (1989, 1990) has observed and/or collected nine adults at three different localities, and has seen many emergence holes in two other areas. Both recent and old holes were present at two (#44,46) of the five sites (#44-46,48,49) surveyed during this study. The elevation in this general area ranges from about 330-400 ft.

Many clumps of elderberry, some huge, were inspected at five sites (#47,50-53) NE of Gravesboro along Piedra Rd. up to Pine Flat Dam (elevation 600 ft.). No evidence of VELB presence was found in this area.

Kaweah River (Tulare Co.)

Four sites (#30-33) in seven areas were examined along the river or tributaries from ca. 7 mi. E of Visalia to just above Lake Kaweah, elevation ~760 ft.; the *Sambucus* in this area occurred in isolated or scattered groups.

A dead adult was found in its exit tunnel near Lane Slough on Rd. J27 ca. 5 mi. N of Exeter (#32) at an elevation of 405 ft. (Figure 63). There were many recent and old exit holes in the three large *S. mexicana* inspected (Figure 64). None of the other *Sambucus* nearby along Deep Creek and Johnson Slough adjacent to Kaweah Oaks Preserve (The Nature Conservancy) (#30,31) had exit holes, nor were any seen at two spots along the south and east shores of Lake Kaweah (Figure 11), the river just above the lake, or the South Fork (#33).

Halstead (1990) and others have collected four dead adults over a four-year period in the Kaweah Power Station #3 hydroelectric flume (Middle Fork) at an elevation of 2200 ft. just SW of Sequoia National Park Ash Mountain Headquarters. Emergence holes were seen in elderberry shrubs/trees nearby. In 1937 a specimen, now in a museum, was collected from Kaweah on the North Fork.

Tule River (Kings, Tulare Co.)

The river downstream from Porterville has little, if any, riparian habitat left (Hanson pers. comm.). Apparently the Creighton Ranch Preserve (The Nature Conservancy) ca. 5 mi. SE of Corcoran used to have *Sambucus*, but they have been killed by the drought (Streeper pers. comm.). Elderberry was very numerous along the river from Porterville to Lake Success. Above the lake clumps became scattered and more sporadic in occurrence; none were seen in the Sequoia National Forest along the Middle Fork up to Coffee Canyon. Ten sites (#14-20,34-36) were surveyed from just S of Porterville to just E of Springville on Hwy. 190.

An adult female VELB (Figure 2) was captured along a railroad right-of-way near the Campbell-Moreland Ditch just to the S of Porterville (#15) at an elevation of ~490 ft. (Figure 62). Lots of exit holes were noted, many of them recent. The host plants, identified as *S. racemosa* var. *microbotrys*, were growing in a tangle of brush composed mostly of dead blackberry canes which appeared to have been treated with herbicide (Figure 32). There were open fields, some with scattered groups of elderberry, outside of the narrow railroad corridor. Several clumps

were examined at two nearby sites (#14,36), including Yaudanchi Ecological Reserve (CDFG) (#36), without finding evidence of the VELB.

Upstream at Rd. 284 not far below Success Dam, elderberry clumps with several recent and many old holes were examined on both the north and south banks (#20,34), elevation 520 ft. (Figure 33). A few massive old trees, one with a maximum diameter of 30 in. (Figure 10), were found to the north of the river along the Bartlett Park (Tulare Co.) fence just below the dam (#35) at an elevation of ~550 ft.; these had a few new and several old exit holes. They had been severely pruned and trimmed, with major trunks cut from one smaller individual (Figure 36). No sign of the VELB was found in vigorous, young and mature clumps growing at the Lake Success Park Headquarters (COE) just below the dam on the south side of the river (#19).

Two sites were examined just above Lake Success (#17,18), and one at the Middle Fork ca. 1.5 mi. E of Springville (#16), elevation ~1100 ft.

Deer Creek (Tulare Co.)

Just one site (#13) was examined on the north bank of Deer Creek ca. 4 mi. NE of Terra Bella at 550 ft. in elevation. One clean-cut old hole, probably made by a VELB, was found in a dead trunk.

Poso Creek (Kern Co.)

Just one solitary elderberry was seen on a route along Poso Creek through Coffee Canyon on Round Mountain Rd. The clump was near the junction of Granite and Round Mountain roads at an elevation of 645 ft. (#12); its main trunks had been cut out. Exit holes were reportedly seen in this area by Shields in 1990 (1990b, 1990c). No *Sambucus* was seen to the north and west in Granite or Corral canyons.

Kern River (Kern, Tulare Co.)

Only very sparse riparian vegetation consisting of willow, cottonwood, and baccharis was seen along the river W of Bakersfield from I-5 to Kern City, and at Goose Lake Slough (tributary of the Kern River) SE of Calders Corner. Elderberry grew abundantly in groves and scattered groups in riparian forest remnants from just NE of Bakersfield upstream at least to the upper end of the Kern River Park (Kern Co.). In the Kern Canyon the *Sambucus* occurred mostly in isolated clumps or small groups on the dry, rocky hillsides along with cottonwood and poison oak.

Riparian thickets, with elderberry a major component, were found along the river and canals below Panorama Park and along China Grade Loop in NE Bakersfield. Several large, healthy *Sambucus* were examined on Chevron Oil Corporation land E of Oildale at the China Grade Loop

(#11), elevation 445 ft. An old, enlarged hole was found in live wood, but its condition was too poor for it to be conclusive evidence of the VELB.

Two distinctly different areas were investigated in Kern River Park above Lake Ming at an elevation of ~520-560 ft. The first, along an access road north of the golf course (#2), was a mostly open, disturbed area. The site had been burned recently, and the six rather young clumps examined were in poor condition with the older branches dead. Shields reported finding emergence holes in this area in 1990 (1990b, 1990c); none were found in the current study. The second site (#1) was upstream at the Game Preserve, a narrow riparian corridor with many scattered *Sambucus* (*S. mexicana*) growing with willow, cottonwood, and baccharis. Some very old, eroded holes were found in dead wood, but it was not possible to determine if they were caused by the VELB.

Isolated clumps of elderberry were inspected at three different spots (#3) in the Kern River Canyon up to ~1300 ft. elevation, 3 mi. into the Sequoia National Forest. Since Shields (1990b, 1990c) had reported finding emergence holes in this area, an attempt was made to locate the same plants he had seen. No holes were found.

No elderberry or riparian vegetation of any kind was present at Cottonwood Creek on Breckenridge Rd. E of Bakersfield, a tributary of the Kern River. The streambed and area were very dry.

Caliente Creek (Kern Co.)

The elderberry along Caliente Creek were previously surveyed by Shields (1990b, 1990c) who noted old holes in poor condition from spots near Loraine to a few miles west of Loraine. During this study, four sites were examined from ca. 1.5 mi. NE of Caliente (#7) up to ca. 3 mi. W of Loraine (#8). Although many very old, unverifiable holes were found in dead wood at two sites, only one (#9), 3.2 rd. mi. W of Loraine at ~2400 ft. elevation, had a partly healed hole in live wood that could have been made by a VELB. Several *Sambucus* were present at a second site (#10) at ~2320 ft. A new hole in live wood was found, but at 0.5 in. (12 mm) diameter, it appeared to be too large to be caused by the VELB. Possibly the hole was made by *Desmoscerus a. auripennis* if the species occurs in the area.

A very isolated, small, young stand of *S. racemosa* var. *microbotrys* was encountered in the dry bed of a tributary of Caliente Creek along Bena Rd. near Ilmon, elevation ~1000 ft. (#4). Although the countryside was open and dry, the spot where the stand grew was surprisingly green with willow, grass, and nettle, probably because of a small spring seep. A partly healed hole was found in a live branch, and, when sectioned, there was a tunnel which appeared to have been made by the VELB.

Sambucus also grew in interesting terrain on another tributary of Caliente Creek along Caliente-Bodfish Rd. SW of Caliente (#6). A thick

grove was found at one spot in a deeply incised dry streambed surrounded by grassy, treeless, rolling hills (Figure 49). No sign of the VELB was found.

Buena Vista Lakebed (Kern Co.)

Virtually no riparian vegetation was seen to the south of Bakersfield, nor to the west at the western edge of the Central Valley. Areas that were searched included: Connecting Slough, and the New and Old River ditches S of Millux; Buena Vista Aquatic Recreation Area (Kern Co.); and W of I-5 to the West Side Canal near the Tule Elk State Reserve (CDPR).

ATYPICAL MALES

Males with dark elytra similar to those of *D. c. californicus* have been collected from the following localities:

Colusa Co., Sacramento River ca. 5 mi. SE of Colusa
Yolo Co., Sacramento River, Knights Landing
Yolo Co., Davis
Merced Co., Merced River
Fresno Co., Kings River
Tulare Co., Lane Slough (tributary Kaweah River)

Although it is possible that these individuals are hybrids or intergrades between the subspecies, none was from the eastern foothills of the Coast Range where a zone of hybridization or intergradation would be expected to occur. There is no apparent pattern to the distribution of these few specimens besides the fact that they were all collected below 410 ft. in the Central Valley.

HABITAT

SPECIES OF *SAMBUCUS* UTILIZED AS HOSTS

Samples of *Sambucus* foliage and flowers/fruit from 34 sites were identified by Lauramay Dempster at the Jepson Herbarium, University of California, Berkeley. Specimens from 19 sites were *S. mexicana* Presl.; those from the other 15 were *S. racemosa* L. var. *microbotrys* (Rydb.) Kearney & Peebles. *Sambucus racemosa* var. *microbotrys* is a new

combination: the species was formerly a synonym of *S. callicarpa* Greene, and the variety was treated as an independent species.

According to Dempster, the two species are fairly easy to separate. *Sambucus mexicana* has a flat-topped inflorescence formed by an abruptly shortened terminal flower stem and longer laterals; the fruits are black with a whitish coating which causes them to appear blue. In contrast, *S. racemosa* var. *microbotrys* has an inflorescence which is pyramidal in shape due to a long, dominant terminal flower stem; the fruits are red.

The two species do not appear to have obviously different habitat preferences. Both occurred in similar plant communities and environmental conditions, ranging from lowland riparian forest to foothill oak woodlands. The elevational range for the *S. mexicana* specimens was 60-2260 feet; *S. racemosa* var. *microbotrys* ranged from 60-1875 feet.

Samples of elderberry were taken from 43.8 percent (28) of the 64 sites where there was evidence of a VELB population. At 53.6 percent (15) of these sites the host plant was *S. mexicana*, at 46.4 percent (13) it was *S. racemosa* var. *microbotrys*. Three of the four adult beetles collected were from *S. mexicana* (two VELB at one site). Identifications of these *Sambucus* samples are given in Appendix II. Although the sample size is too small to definitively determine whether or not the VELB exhibits host preference at the species level, it appears that the beetle inhabits whichever *Sambucus* spp. that is available. Of six specimens taken from sites where the VELB seemed not to be present, four were *S. mexicana*, and two were *S. racemosa* var. *microbotrys*.

SAMBUCUS PHYSICAL CHARACTERISTICS AND CONDITION

GROWTH FORM AND PHENOLOGY:

Sambucus may be arborescent, tree-like, with one to a few trunks (Figures 9, 10), or may form bushy, many-stemmed clumps (Figures 11, 12). It appears that very old individuals, those growing beneath mature overstory canopies, and especially those that have been systematically pruned, are more likely to be arborescent. The VELB did not seem to prefer plants with any particular growth form.

Many dead branches and shoots were commonly associated with healthy, vigorously growing plants; this seemed to be a normal occurrence not necessarily indicating poor condition (Figures 20, 33).

The time of flowering varied widely between different localities and even between plants within a single locality. Groups in pre-bloom and those in full bloom were often seen at the same site. Some were still blooming in September over a month after the field survey had ended.

Flowers and fruit were rarely present simultaneously on the same individual. All three of the adult VELBs collected during the study were on plants in flower.

SIZE:

Due to time constraints, it was not possible to do exhaustive stem measurements and counts on the elderberry plants examined. Instead, the maximum diameter of the largest branch or trunk in a group (tree/clump/grove) was used as an indicator of overall size and maturity.

The majority of elderberry groups (63.8 percent), both with and without exit holes, had maximum diameters >3-9 inches. The diameters of groups in the overall measured population ranged from 1.0-30.0 inches, with a mean of 7.5 inches (n=250). See Figure 34.

That of groups with exit holes ranged from 2.5-30.0 inches, with a mean of 8.1 inches (n=80 holes). For groups with recent exit holes the range was the same, but the average diameter was an inch larger, 9.2 inches (n=38). The reason for this is not known. Because of growth subsequent to the creation of a hole, the diameters of *Sambucus* with recent exit holes were more reliable indicators of size than those with just old holes.

In their Sacramento River study, Jones and Stokes (1987b) found that the basal diameter of the largest stem in 285 clumps with exit holes was 2-6 inches more than 60 percent of the time, and 26 percent were larger than 6 inches. In contrast, only about 41 percent of elderberry groups with holes in this study had maximum diameters of 2-6 inches, and almost 59 percent had diameters larger than 6 inches. Eya (1976) reported that the VELB prefers elderberry shrubs/trees with basal diameters of 15-65 cm (6-26 inches).

During the course of the study no exit holes were found in exclusively young stands. In fact, they were not seen in any *Sambucus* with maximum diameters of less than 2.5 inches. This supports the Jones and Stokes (1987a) conclusions that the VELB may have a limited ability to colonize young stands. Conversely, another Jones and Stokes study (1987b) reported that 10 percent of clumps with VELB were less than 2 inches in basal diameter. Arnold (1986) stated that his observations indicated that the majority of adults and larvae infest younger elderberry plants with trunk diameters of no more than a few inches.

HEALTHY AND STRESSED:

The great majority, 81.7 percent, of the *Sambucus* surveyed were healthy, with bright green foliage, vigorous new growth, and abundant inflorescences; only 14.5 percent were considered to be in poor condition (n=504) (Figure 35). A definite seasonal trend was noted, with only an occasional unhealthy plant seen during the spring, but many in July. If seasonality is a factor, the data will be biased because the study was conducted from April through July. As the weather became hotter and the soil drier, an increasing number of plants with yellow, droopy foliage and dying young shoots were encountered. This may be a normal annual phenomenon resulting from typical climatic conditions, or it may be exacerbated by the cumulative effects of five years of drought. Munz (1959) noted that *S. mexicana* is "often quite deciduous in the dry season." Riparian and other plants growing near good water sources seldom appeared to be in poor health.

When considering *Sambucus* health in relation to VELB presence, a strong parallel was found with the health of the overall surveyed elderberry population (Figure 35). This indicates that VELB presence is not a factor in producing unhealthy plants, and also the converse, that unhealthy plants are not a factor in VELB presence. In groups of elderberry with the VELB, 82.5 percent were healthy, 4.9 percent were fair, and 12.6 percent were unhealthy (n=103). All three of the living adults collected were from healthy clumps. If a seasonal health trend is normal, then the VELB emergence period would occur before the elderberry plants are greatly impacted by the dry season. The long-term, non-seasonal health of the plants may change with time, therefore it is not possible to know their condition over the entire period of infestation.

There has been much discussion about whether the VELB is attracted to "stressed" *Sambucus*. These are plants with smaller, yellow-green leaves that are deciduous earlier than normal (Environmental Science Associates 1986). Arnold (1984) hypothesized that stressed plants aid in VELB mate location by functioning as congregation sites. He intentionally stressed elderberry shrubs at four localities by slashing and girdling, and subsequently observed adults on the damaged plants at three of them. A larger sample size and more observations would be needed to ascertain that they were attracted specifically to those plants: the beetles also may have emerged from them (there was no mention of exit holes), or have been present by chance. Arnold (1986) and Kellner (Environmental Science Associates 1986) also reported that the majority of adults they have sighted were in association with stressed or young elderberry plants. Both Jones and Stokes (1987b) and Halstead (1991a) have observed that VELB adults emerge from both healthy and stressed *Sambucus*; Jones and Stokes believed that there was an equal likelihood for either situation. The adults collected during this study were taken from healthy, undamaged clumps of elderberry. Plants that had been recently injured were seldom encountered.

DAMAGE DUE TO HUMAN ACTIVITIES:

Damage to *Sambucus* caused by people was primarily from cutting and burning. Some type of injury was evident at 16.7 percent (38) of the sites surveyed, and 39.5 percent (15) of these had VELB populations. Herbicide damage was suspected, but unverified, at a couple of sites.

Elderberry shrubs/trees at 20 sites were affected by pruning, trimming, and/or cutting (Figures 36-39). These plants were primarily growing in parks; adjacent to paths, roadways, and parking lots; and along fences, levees, and cultivated fields or orchards. Some had only been pruned of branches and trunks that interfered with human activities, but others had major trunks or the entire plant removed at some time in the past. In the latter case, young shoots often came up around the old stump and eventually disguised it as they grew (Figure 39). One orchard owner stated that the elderberry shrubs on her property kept coming back up despite being cut down every couple of years. Although the damage at most sites was several years old, some was recent.

Soot and burns were seen on *Sambucus* at 18 sites (Figures 40, 41). Most of the stands that had fire scars grew along levees which are periodically burned to control brush. Some of these plants looked unhealthy with sparse foliation, but most did not seem to be seriously harmed.

The effect of herbicides on the elderberry at three sites was unknown or speculative. At one (#15) herbicides had been used to kill brush consisting mainly of blackberry brambles, but the *Sambucus* and other trees appeared to be unharmed (Figure 32). At the other two sites (#84,85) where roadside plants were adjacent to large cultivated fields, many had twisted, yellowish foliage. Others nearby, but not bordering the fields, looked healthy. Jones and Stokes (1987a) cited elderberry deaths from herbicides at the Cosumnes River, as well as damage from frequent cutting.

SAMBUCUS HABITAT AND PLANT COMMUNITIES

Sambucus was found growing in several types of situations, and was not necessarily restricted to riparian areas. It occurred as both an understory and overstory plant. Although an analysis of habitats and plant communities was not attempted, some general observations were made in the course of the study.

The largest concentrations of elderberry were encountered in remnants of the Great Valley Mixed Riparian Forest and Great Valley Oak Riparian Forest (Holland 1986) along the rivers and larger streams of the Central Valley (Figure 42). In these areas the bushes do not grow

immediately adjacent to the watercourses, but in upland areas, on natural levees and terraces, or on the slopes or at the bases of artificial levees. They also were frequently scattered in Elderberry Savannas (Holland 1986) adjacent to riparian forests (Figure 43), in pastures (Figure 44), and along fencerows (Figure 45). Common woody plant associates included *Populus* sp. (cottonwood), *Salix* sp. (willow), *Fraxinus* sp. (ash), *Quercus* spp. (oak), *Juglans* sp. (walnut), *Acer negundo* (boxelder), *Ailanthus altissima* (tree of heaven), *Rubus* sp. (blackberry), *Rhus diversiloba* (poison oak), *Vitis californica* (grape), and *Rosa* sp. (rose), as well as *Baccharis* sp. in the southern part of the Central Valley.

Adjacent to the Central Valley in the foothills of the Sierra Nevada and Coast Range, elderberry occurred in both oak woodlands (Figure 46) and mixed chaparral-woodland communities (Figure 47), sometimes growing right on the banks of smaller streams. Occasionally plants were found in areas that were not considered riparian. Unlikely appearing places were dry hillsides (Figure 48) and rocky canyon walls, and open fields some distance from surface water. In these situations the bushes were often tucked in low areas, even roadside ditches and culverts, that would periodically collect water. A few times in the arid southern San Joaquin Valley, elderberry and other plants were seen in isolated patches along dry streambeds in areas where ground water was available near the surface (Figure 49).

Sambucus was observed most frequently in mixed plant communities. However, it often occurs nearly alone in altered and artificial situations such as along levees, roadside ditches, and in maintained yards and pastures, and is the characteristic woody plant of the Elderberry Savanna (Holland 1986).

The VELB was present in all of the communities in which elderberry grew, but it was more common in riparian woodlands and savannas. This was perhaps due to the greater concentrations of host plants in these areas. Inhabited *Sambucus* grew as either an understory or overstory plant.

SAMBUCUS DENSITY

The density of elderberry at a particular site was subjectively determined as detailed in the Materials and Methods section. These data reflect the situation only in the areas surveyed, not that of the overall elderberry population.

At all 230 sites, isolated groups were encountered 42.2 percent of the time, and scattered groups, 41.3 percent. At the 64 sites where the VELB was present, elderberry groups were isolated at 18.8 percent, scattered at 56.3 percent, and many at 20.3 percent. Figure 50 contrasts elderberry density at all sites with those utilized by the

beetle. Although isolated and scattered plants were encountered almost equally overall, three times as many sites with scattered plants hosted the VELB. The percentage of all sites with many groups was almost a third lower than the percentage of sites with such groups selected by the VELB. These figures support the assumption that the VELB prefers areas where elderberry groups are not isolated from each other.

EXIT HOLES

FIELD OBSERVATIONS

Only clean-cut holes of the proper size and shape were considered to be evidence of VELB habitation (Figures 6, 7, 13-15). Eroded and weathered holes, or those enlarged by birds or other insects, were frequently encountered but were usually unverifiable (Figures 17, 18). Old, dead branches and trunks are often invaded by insects that live and feed in dead wood, such as termites (Isoptera) (Figures 16, 61), bostrichid beetles (Coleoptera: Bostrichidae) (Figure 60), and ants (Hymenoptera: Formicidae) (Figures 56, 58, 59). Their galleries and holes do not resemble those of the VELB, but their invasion secondarily can damage or obliterate evidence of prior VELB presence (Figures 56, 57).

The distribution of survey sites, with VELB presence or absence indicated, is illustrated in Figure 8. A total of 186 exit holes were recorded during the survey. Exit holes were found at 27.8 percent (64) of the 230 sites examined (3 sites with unverifiable holes were excluded), and in 20.4 percent (103) of the total counted elderberry groups (n=504).

Thirty-three, or 51.6 percent, of the sites had recent VELB holes in addition to old holes from previous years. At some of the remaining 31 sites where only old holes (including healed holes) were seen, early season sampling before adult emergence may have been a factor. Of the elderberry groups with exit holes, 44.7 percent (46) had recent holes.

Exit holes were numerically sorted by age/condition, and by whether they occurred in living or dead stems (n=186) (Figure 51). The largest group was recent holes in live wood with 40.9 percent, followed by old and old poor holes in dead wood with 24.2 percent. The occurrence of healed and partly healed holes (Figures 14, 15) has not been previously reported by other observers or researchers. These were noted in live wood 16.1 percent of the time, and in dead wood, 1.1 percent. It appears that in healthy, actively growing stems, the hole is eventually closed by new growth. This would be advantageous for the plant since exit holes offer easy entry for secondarily invading insects and

diseases. Holes also could be difficult to detect if they had been packed with frass by other insects such as termites (Figure 16).

Jones and Stokes (1988) sectioned 17 stems from three different clumps and found that many vacant galleries were apparently unaccompanied by exit holes, or that the holes were not visible externally. They concluded that this may have been due to larval VELB mortality. Observations from the current study suggest that, in the latter case, it is also possible that some of the holes healed over and were no longer very obvious externally.

BRANCH OR TRUNK DIAMETER AT EXIT HOLE:

Recent, current-year emergence holes are the most reliable for determining the preferred branch size at time of pupation. Unless the stem died shortly after the adult emerged, it would have continued to grow during the intervening time interval. Recent exit holes (n=70) were found in branches and trunks ranging from 1.0-8.4 inches in diameter, with a mean of 3.5 inches. The diameters of all of those with holes (n=138) ranged from 0.6-10.0 inches, with a 3.3 inch mean; the largest number was in branches of >2-4 inches. Figure 52 compares these frequencies.

Jones and Stokes (1987b) estimated the stem diameters at 49 current-year exit holes along the Sacramento River. They similarly ranged from 1-8 inches, but 66 percent were in stems of less than 3 inches, and the majority, 40 percent, in the 2-2.5 inch size class. In this survey only 41.5 percent were 3 inches or smaller, and 50 percent were in branches >2-4 inches. Jones and Stokes (1988) reported a mean of 3.21 inches and a range of 1.38-6.60 inches for diameters of stems with galleries in a study of *Sambucus* inhabited by the VELB at the Cosumnes River. Andrews et al. (1987) found that for *D. c. californicus* holes, the frequency of utilization of stems for VELB development paralleled the frequency of occurrence of stem sizes on the study site.

Exit holes in very small diameter stems were not frequently encountered in this study, and in all but one instance they were growing from larger branches or trunks. Most of these stems were collected and later split longitudinally to verify former VELB activity and examine the gallery. Small diameter stems had a proportionally very large pith diameter comparable in size to that of much larger stems, and the VELB tunnel occupied most of it. There were eight measurements of young stems one inch or smaller in diameter with exit holes (Figures 53, 54), and 22 of stems 1.5 inches or smaller. This contradicts Jones and Stokes' (1988) conclusion that the VELB does not appear to use stems less than about 1.5 inches in diameter. Actually, small stems may be under-represented because of insufficient time for larval development and pupation. Most of the very small (<1 inch) diameter stems with holes were dead, raising the possibility that they were killed by the

VELB. It is likely that stems of this size grew from new shoots within the postulated two year period of VELB occupation (Jones and Stokes 1987b).

VERTICAL HEIGHT OF EXIT HOLE:

The heights of emergence holes varied widely from near the ground to nine feet high. The vast majority were within an easily examined height. The data are probably biased due to the difficulty of spotting the often cryptic holes in higher trunks and branches. Although trees were climbed when feasible, it was not usually possible to conduct a thorough search.

For all exit holes surveyed (n=122), as well as recent ones (n=68), the heights ranged from 6-108 inches (0.5-9.0 feet) (Figure 55). The overall mean was 38.8 inches (3.2 feet), and the mean for recent holes was 41.5 inches (3.5 feet). Almost 71 percent of all holes were 48 inches (4 feet) or less in height; nearly 56 percent were 36 inches (3 feet) or less. These results parallel those of Eya (1976), Jones and Stokes (1987b), and Andrews et al. (1987). Jones and Stokes estimated stem heights at 627 exit holes and found that nearly 70 percent were at or below 4 feet, and only about 10 percent were higher than 6 feet. Andrews et al. found *Desmocerus californicus* holes from ground level up to 7 feet high. Of 133 measurements, 65 percent were less than 3 feet high, and 35 percent were between 1-2 feet. Eya reported holes from 10 cm to 3 m (0.3-10 feet) from the ground, and Halstead (1991a) has found emergence holes up to 25 feet high.

SAMBUCUS WOOD SAMPLES

In most cases, it was possible to confirm past VELB larval activity in branches with potential exit holes by examining longitudinally cut sections (Figures 4, 5, 53, 54). A few times the wood had been dead for too long, and secondary invasion by other insects had obscured or obliterated whatever galleries may have existed (Figures 56-58). Other insects that were found boring in the wood were termites (Isoptera), carpenter ants (Hymenoptera: Formicidae), and bostrichid beetles (Coleoptera: Bostrichidae); none of these made galleries and exit holes with the characteristics of those made by the VELB (Figures 59-61). Other arthropods that inhabited the tunnels included spiders, earwigs (Dermaptera), ants, and perhaps bees.

ADULT BEETLES

FIELD OBSERVATIONS

All of the adults observed during the study were captured. Each of the four beetles was found in different positions on the host plant. Female #1 (Figure 2) was on a 4.8 inch diameter trunk near the center of a clump, 60 inches above the ground (Figure 62). Male #1 (Figure 63) was dead in an exit hole, his head nearly flush with the bark; he had been dead for at least several days, and the cause was not apparent. The hole was in a 2 inch diameter stem near the center of a clump, 52 inches from the ground (Figure 64). Female #2 and Male #2 (Figures 1, 66) were taken at the same site, but on widely separated clumps of elderberry (Figures 45, 65). Female #2 was positioned about 84 inches above ground on the underside of foliage growing on the outer margin of the elderberry crown. Male #2 was on the upper side of a leaf inside the canopy and near the center of the clump, about 72 inches above ground.

On each of the occasions the weather was warm and sunny, and the time was 4:00-5:30 pm. None of the beetles were seen flying, nor the females, ovipositing. Three of the host plants were growing in open areas, and one was growing amidst other trees and brush. None were understory plants or in completely shaded situations.

SCARCITY OF ADULT COLLECTIONS

Adult valley elderberry longhorn beetles can be surprisingly cryptic in the dense foliage or shady interior of the elderberry crown during the brief period in which they are extant. One of the reasons for the overall small number of adults observed or collected historically, as well as in the current study, is that no efficient means of locating them has been discovered. Chance and luck apparently play a large part in finding them.

The large geographic scope of this project coupled with the small number of investigators also probably contributed to the low number of adults seen and captured. In order to determine the range of the VELB, it was necessary to spend time in areas from which it had not been recorded. Sites were not visited more than once, even those with many exit holes. At some of the sites investigated in the early part of the field study, it was probable that this year's emergence had not begun yet.

The strategy of returning periodically during the emergence period to those sites with exit holes may have resulted in more collections. This method was used successfully by both Jones and Stokes (1985, 1986, 1987b) and Arnold (1984, 1985), who surveyed for exit holes during one season or year, then returned to likely spots during the emergence period. Even then, only 10 adults were collected on the Sacramento River by Jones and Stokes during three years of field work by teams of up to seven people; one year, none were collected. Andrews et al. (1987) inhabited the field study site on Los Banos Creek for almost three months, but collected only two possible specimens of *D. c. californicus* even though 17 fresh exit holes were discovered.

LABORATORY OBSERVATIONS

The three valley elderberry longhorn beetles captured alive were maintained until they died, presumably of natural causes. They fed on a diet of fresh elderberry leaves and did not appear to eat flowers. The male lived 17 days in captivity, and each of the females lived 25 days.

The male and female captured at the same site were placed together and began mating within a day (Figure 66). Eggs were observed within three days. Mating continued off and on for at least five days. Eighty or more eggs were produced, and about half of these hatched. Female #1 (Figure 2) laid 110 eggs in captivity. Most of the eggs were attached to the leaves and stems of the foliage offered as food. Leaf petiole-stem junctions, leaf veins, and other spots with crevices and depressions were favored for oviposition. The eggs were firmly attached with an adhesive.

Halstead (1991a) noted that females oviposit in a variety of locations, and may even place several eggs close to each other. This was true of the captive females in this study, but they also had very limited choices. Andrews et al. (1987) thought that the selection of oviposition sites in natural situations is independent of branch size and is possibly random.

POPULATION STATUS

Even though this study was not aimed at determining the population status of the valley elderberry longhorn beetle, some related information can be reported. Of 103 groups of *Sambucus* with VELB exit holes, 44.7 percent (n=47) had recent (current year) holes; at the 64 sites with exit holes, 51.6 percent (n=33) had recent holes. These figures are likely an underestimate of the active populations because,

at some elderberry surveyed early in the season, adult emergence may not have occurred yet.

No sign of a VELB population was found at several localities where exit holes and/or adults had been previously reported:

(1) Sacramento River near RM 271E, Tehama Co. southeast of Cottonwood (Site #57; Halstead 1990, exit holes)
(2) Mokelumne River at Woodbridge Regional Park (Site #144; Arnold 1985, adult)
(3) Middle River southwest of Stockton (Sites #80-85,135; Arnold 1984, 1985, adult and exit holes)
(4) Stanislaus River at Caswell Memorial State Park (Site #196; Holland 1985b, exit holes)
(5) Merced River at McConnell State Recreation Area (Site #193; Arnold 1984, 1985, adults and exit holes)
(6) Poso Creek northeast of Bakersfield (Site #12; Shields 1990b, 1990c, exit holes)
(7) Kern River at Kern River Park just northeast of Bakersfield (Sites #1,2; Shields 1990b, 1990c, exit holes)
(8) Kern River in the Kern River Canyon (Site #3; Shields 1990b, 1990c, exit holes)

Failure to find evidence of VELB populations at these sites does not necessarily mean that they are no longer extant. Because exit holes are present in only a small number of *Sambucus* at many sites, they could have been missed. This clustered aspect of distribution is discussed in the Conclusions.

At two sites on Bear Creek, a tributary of the Mokelumne River, where Arnold reported exit holes in 1984, no *Sambucus* was found.

OWNERSHIP OF HABITAT

In order to determine where VELB populations occur in potentially protected locations, extra effort was directed at parks and wildlife areas. Table 1 lists the acreages of such areas, both surveyed and not surveyed, and indicates the current and historic presence/absence of elderberry and VELB populations; Table 2 summarizes the information contained in Table 1..

Fifty-three sites, 23 percent of the total, were surveyed in 40 parks or wildlife areas. Of these, 39.6 percent of the sites and 37.5 percent of the parks/wildlife areas had *Sambucus* with VELB emergence holes. Two of these were private reserves (Audubon, The Nature Conservancy).

Elderberry residing in such areas was not necessarily protected from intentional injury. There were several in which plants had been quite severely pruned and trimmed, even those with exit holes (Figures 36-38). Fire-scarred *Sambucus* were found in one state park, but that damage was probably accidental.